Microbiology

Abhay
CRRI, Madras Medical College & RGGGH, Chennai, Tamilnadu -600003

R. Deepa*
M.D.(Microbiology), Associate Professor of Microbiology, Govt. Villupuram Medical College & Hospital, Villupuram, Tamilnadu-605601 *Corresponding Author

S. Thasneem Banu
M.D.,(Microbiology), Professor of Microbiology, Madras Medical College & RGGGH, Chennai, Tamilnadu-600003

ABSTRACT

Introduction:Patients in Surgical Critical care units are at high risk of developing urinary tract infections due to need for urinary catheterization for various indications and underlying risk factors.

Aim: To determine incidence, risk factors and microbial profile of Catheter associated Urinary tract Infection (CAUTI) in the surgical Intensive care unit (SICU) and to determine the catheter care practices.

Materials and Methods: The prospective study conducted in the SICU for a period of two months included all consecutive patients with an indwelling urinary catheter at the time or discontinued within 48 hours before onset of symptoms suggestive of urinary tract infection. Semiquantitative urine culture and antimicrobial susceptibility testing was performed by standard methods. Diagnosis of CAUTI was done according to National Health Safety Network definitions. A point prevalence survey was done to determine the indications of catheterization and Catheter care practices. Risk factor assessment was done by univariate analysis.

Results: Among the 36 patients who satisfied the inclusion criteria,7 of 36 patients (19.4%) developed CAUTI. Among them, SUTI 1a was detected in 6 patients (85.7%), and SUTI 2a in 1 patient (14.3%). The average CAUTI rate was 12.9 per 1000 catheter days. The mean duration of inserted catheter was 16.1 days. The etiological agents of CAUTI were Escherichia coli (50%), Klebsiella pneumoniae (30%) and Enterococcus faecalis (20%). Extended spectrum betalactamase production was detected in 25% of the gram negative bacterial isolates. Duration of catheterisation was a major risk factor significantly associated with CAUTI. One day assessment of catheter care practices showed 100% compliance in 50% of catheter care practices.

Conclusion: CAUTI is an important cause of hospital acquired infections in the SICU. A major modifiable risk factor is the duration of catheterisation. Preventive strategies include strict adherence to sterile catheter care practices and surveillance of the high-risk areas.

KEYWORDS

Catheter associated Urinary Tract Infection, risk factors, Surgical intensive care unit

INTRODUCTION

Health care associated infections (HAI) are those that are acquired during the treatment course for other illnesses within a health care setting. Catheter associated urinary tract infections (CAUTI) account for about 40% of the HAIs and account for increased mortality, morbidity, increased length of hospital stay, hospital cost and unnecessary antimicrobial use. 70-80% of these are related to presence of an indwelling catheter. The daily risk of acquisition of UTI ranges from 3% to 7% in the presence of indwelling urethral catheter.

The risk of acquiring UTI is dependent on several factors including duration of catheterization, quality of catheter care and host susceptibility. The most important goal towards preventing CAUTI is tackling unnecessary catheter use. Disrupting the life cycle of the catheter through intervention measures aimed at catheter placement, catheter care, catheter removal and catheter reinsertion provides a framework for prevention of CAUTI.

Organisms causing nosocomial UTI easily colonize and establish infection as they require fewer virulence factors than organisms infecting a normal urinary tract. The indwelling urethral catheter facilitates ascension of uropathogens through the catheter-mucosa interface and allows for intra-luminal spread of pathogens to the bladder. Formation of bio-films especially with long-term catheters inherently protect uro-pathogens from antimicrobials and the host immune response thus leading to antimicrobial resistance.

Implementation of a multidimensional UTI prevention bundle has been shown to reduce CAUTI rates in critical care units. These include specific bundle of interventions for CAUTI prevention, education, outcome surveillance, process surveillance, feedback of CAUTI rates and performance indices of infection control practices. Infection Surveillance plays an important role in identifying the deficiencies of infection control measures.

The CAUTI incidence rates vary between hospitals and within various facilities of a hospital. Therefore it is imperative that each hospital has its own data on HAI.

Patients in Intensive Care Unit patients as these patients have relatively higher rates of CAUTIs. Among the patients in the ICUs, UTI accounts to about 36.6% of the HAIs. This study is aimed at performing surveillance of CAUTI in a surgical postoperative intensive care unit.

Aims & Objectives:
The present study had the following aims
1. To determine the CAUTI incidence rates during the study period and study the risk factors in the patients.
2. To determine the microbial etiology of CAUTI and their antimicrobial susceptibility pattern.
3. To determine the indications and practices of Foley Care practices in the surgical intensive care unit

MATERIALS AND METHODS

Study design and setting: This prospective study was conducted in the 20 bed Surgical Intensive care unit of the tertiary care hospital for a period of two months from August 2017 to September 2017 where all adult patients undergoing various surgeries required critical care postoperatively. All consecutive patients who had an indwelling urinary catheter at the time or discontinued within 48 hours before onset of the event, and developed symptoms suggestive of UTI who met the criteria defined by Centre for Disease Control (CDC)/National Healthcare Safety Network (NHSN) of Symptomatic UTI were included.

Patients with suprapubic catheters, condom catheter, straight in and out catheters, nephrostomy tube, urostomy, ileal conduit were excluded. The study was approved by the Institutional Ethics Board and patient’s consent obtained.

Sample collection: In patients with an indwelling catheter, the sampling port was disinfected with 70% alcohol. The catheter below the port was clamped and 5 -10 ml urine collected in a sterile screw capped container.

In non-catheterized patients the first morning void of midstream, clean-catch specimen was collected. Urine specimens were transported to the laboratory immediately and processed within 2
hours of collection.

**Semi quantitative Culture of urine:** Bacterial culture of urine was performed by inoculating of 0.01 of specimen using a calibrated wire loop to Cystine Lactose Electrolyte Deficient media and 5% sheep blood agar plates and incubated at 37°C for 24 hrs. The colonies were counted and expressed in cfu/ml. The identification of the bacteria and yeasts were performed according to standard procedures. The antibiogram was done by Kirby Bauer Disc diffusion method and interpreted as per CLSI guidelines.

**Blood culture:** If there were signs of bacteremia, 10 ml of blood was drawn for culture under aseptic precautions and inoculated into brain heart infusion broth (BHI) and processed according to standard procedure.

**Interpretation of cultures:**

In patients with an indwelling catheter at the time of specimen collection or discontinued prior to 48 Hours, a positive urine culture of >10^5 CFU/ml with no more than 2 species of organisms was categorised as SUTI-criterion 1a. and a positive urine culture of >10^4 and <10^5 CFU/ml with no more than 2 species of microorganisms was categorised as SUTI-criterion 2a.

Urine cultures with > 2 organisms were regarded as contaminated cultures.

Urine culture with yeast were included if there was at least one bacterium with ≥10^5 CFU/ml and no more than 2 organisms. Organisms of same genus but different species were regarded as two organisms. The same organism with different antimicrobial susceptibilities was considered as single organism.

**Data collection:** The presence of signs and symptoms of UTI was obtained by history and clinical examination and information from medical case record. The outcome variable measured was CAUTI incidence rate. The denominator data (Indwelling urinary catheter days) was determined by counting the number of patients who had urinary catheters in place at the same time on each day of the week. The NHSN formula was used to calculate the incidence rate for CAUTIs.

Number of new CAUTIs X 1000 total number of catheter days

**Point prevalence survey:** At the end of first month a point prevalence survey for risk assessment was conducted using a survey tool by observation and from medical case record of the patient for monitoring trends in Foley care practices. The compliance rate of catheter insertion and removal dates and documentation of indication of catheter placement were calculated to measure the process.

**Microbiological Diagnosis of CAUTI**

**Statistical Analysis:** The CAUTI rate per 1000 urinary catheter days was calculated by dividing the number of CAUTIs by the number of catheter days and multiplying the result by 1000. The Urinary Catheter Utilization Ratio was calculated by dividing the number of urinary catheter days by the number of patient days. The risk factor assessment was done by univariate analysis.

**RESULT**

Thirty six patients in the age range of 18-75 yrs. (mean age 51.4 years) with a 26 males and 10 females (13:5) satisfied the inclusion criteria. These patients had been admitted for abdominal surgeries [n=20/36(55.5%)], respiratory tract associated [n=2/4(50%)], genitourinary tract surgeries[4/24(16.6%)] and other general surgeries [n=10/36(27.7%)]. The mean duration of having an inserted catheter was 16.1 days. The device utilisation rate was 0.75 and 0.73 in August and September respectively.

Seven of 36 patients (19.4%) developed CAUTI. Among them, SUTI 1a was detected in 6 patients (85.7%), and SUTI 2a in 1 patient (14.3%). Seven of 36 patients (20.5%) developed CAUTI, of which 19.4% were SUTI 1a and 14.3% were SUTI 2a. The incidence rate of CAUTI was 13.9 and 11.8 per 1000 catheter days in August and September 2017 respectively with an average of 12.9 per 1000 catheter days for the two month period (Table 1).

**Table 1 Characteristics Of Study Population**

<table>
<thead>
<tr>
<th>Month</th>
<th>Mean age of patients</th>
<th>Gender</th>
<th>No. Of Patients</th>
<th>No. Of patients with CAUTI</th>
<th>Patient days</th>
<th>Catheter days</th>
<th>Catheter utilization rate</th>
<th>CAUTI Incidence rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>August 2017</td>
<td>50.6</td>
<td>Males :15 Females:4</td>
<td>19</td>
<td>4</td>
<td>378</td>
<td>287</td>
<td>0.75</td>
<td>13.9/1000</td>
</tr>
<tr>
<td>September 2017</td>
<td>52.8</td>
<td>Males: 11 Females:6</td>
<td>17</td>
<td>3</td>
<td>343</td>
<td>253</td>
<td>0.73</td>
<td>11.8/1000</td>
</tr>
</tbody>
</table>

During the one day assessment of the catheter care practices, it was observed that among 20 patients admitted in the unit, 14 patients (70%) had an indwelling catheter. Of those 14 patients, 100% met indication criteria at the time of urinary catheter insertion. The surveillance also showed 100% compliance in noting the date of insertion, catheter securement, positioning the drainage tubing to promote downhill flow of urine with no dependent loops and in documenting daily catheter care. In addition, 92.6% compliance was found in leaving the tamper-evident seal intact and in securing the Drain tubing clip to sheet (Table 2).

**Table 2 Individual Patient Survey Tool (n=14)**

<table>
<thead>
<tr>
<th>Indications</th>
<th>No. of patients n(%)</th>
<th>Care Practice assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient has acute urinary retention or bladder obstruction</td>
<td>0(0)</td>
<td>Insertion date, time, unit placed, and initials noted on urine bag with permanent marker</td>
</tr>
<tr>
<td>Need for accurate measurement of urinary output in critically ill patients</td>
<td>11(78.6%)</td>
<td>Catheter securement to inner aspect of thigh with tape/strap</td>
</tr>
<tr>
<td>To assist in healing of open sacral or perineal wounds in patients who are incontinent</td>
<td>0(0)</td>
<td>Catheter securement leaving 1” slack in tubing</td>
</tr>
<tr>
<td>Patient requires prolonged immobilization</td>
<td>1(7.1%)</td>
<td>Catheter tubing is NOT twisted, kinked, or with dependent loop</td>
</tr>
<tr>
<td>To improve comfort for end-of-life care if needed</td>
<td>0(0)</td>
<td>Drain tubing clip secured to sheet (to maintain proper gravity flow)</td>
</tr>
<tr>
<td>1. Patients undergoing urological surgery or other surgery on contiguous structures of the genitourinary tract</td>
<td>1(7.1%)</td>
<td>Catheter bag positioned lower than bladder to prevent back flow</td>
</tr>
<tr>
<td>2. Anticipated prolonged duration of surgery</td>
<td>0(0)</td>
<td></td>
</tr>
<tr>
<td>3. Patients anticipated to receive large volume infusions or diuretics during Surgery</td>
<td>2(14.3%)</td>
<td></td>
</tr>
<tr>
<td>4. Need for intra-operative monitoring of urinary output</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Catheter placed by a trained competent person                             14(100)

Is daily catheter care being documented?                                  14(100)

**International Journal of Scientific Research**
Physician documented reason for Foley in place greater than 2 postoperative days 14(100%) Drainage bag is NOT touching floor 12/14 (85.7%)

Patient criteria for Foley catheter met 14 (100%) Drainage bag is NOT over filled 12/14 (85.7%)

The etiological agents of CAUTI were *Escherichia coli* [4 of 7 isolates(50%), *Klebsiella pneumoniae* [1 of 7 isolates(30%)] and *Enterococcus faecalis* [2 of 10 isolates(20%)]. Amongst the family Enterobacteriaceae, reduced susceptibility(≤ 50%) was noted to Ampicillin,Trimethoprim, Nitrofurantoin , (*Table 3*). One of 4 isolates (25%) of family Enterobacteriaceae was an Extended Spectrum Beta lactamase producer. This isolate was susceptible to carbapenems. Both isolates of *Enterococcus faecalis* were susceptible to Nitrofurantoin, Ciprofloxacin, Tetracycline, high level gentamicin and Vancomycin and resistant to Penicillin and Ampicillin. Eleven of 36 patients had fever(>38°C (30.5%). There was no growth in blood culture in these patients.

**Table 3 Antibiotic Susceptibility pattern of Enterobacteriaceae isolates (n=5)**

<table>
<thead>
<tr>
<th>Bacterial isolates</th>
<th>Amp</th>
<th>Cfx</th>
<th>Gm</th>
<th>Ak</th>
<th>AMC</th>
<th>Tetra</th>
<th>Cip</th>
<th>Tmp-Sx</th>
<th>Nt</th>
<th>Imp</th>
<th>No.</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Escherichia coli</em> (n=4)</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>75</td>
<td>N</td>
<td>75</td>
<td>4</td>
<td>100</td>
<td>4</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td><em>Klebsiella pneumoniae</em> (n=1)</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>100</td>
<td>0</td>
<td>100</td>
<td>1</td>
<td>100</td>
<td>1</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

Clavulanate,Tetra, Tetracycline; Cip-Ciprofloxacin ,Tmp-Sx -Trimethoprim sulphamethoxazole;Nt-Nitrofurantoin;Im-Impimen

Analysis of the patient related risk factors showed that the duration of catheterisation of more than 48hrs had a significant association with the development of CAUTI(*Table 4*).

**Table 4 Patient Related Risk Factors For CAUTI**

<table>
<thead>
<tr>
<th>Risk factors</th>
<th>Patients with CAUTI (n=7)</th>
<th>Patients without CAUTI (n=29)</th>
<th>Fisher Exact value / Significance at P&lt;0.05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female gender</td>
<td>3</td>
<td>7</td>
<td>0.166(not significant)</td>
</tr>
<tr>
<td>Age &gt;50 yrs</td>
<td>3</td>
<td>11</td>
<td>1(not significant)</td>
</tr>
<tr>
<td>Immune status of the host: Long term use of steroids</td>
<td>nil</td>
<td>nil</td>
<td>--</td>
</tr>
<tr>
<td>Prolonged illnesses- HIV</td>
<td>nil</td>
<td>nil</td>
<td>--</td>
</tr>
<tr>
<td>Autoimmune diseases</td>
<td>nil</td>
<td>nil</td>
<td>--</td>
</tr>
<tr>
<td>Malnutrition</td>
<td>2</td>
<td>9</td>
<td>1(not significant)</td>
</tr>
<tr>
<td>Select co-morbid conditions: Diabetes/ Hypertension/Renal failure.</td>
<td>1</td>
<td>14</td>
<td>0.200(not significant)</td>
</tr>
<tr>
<td>Prolonged iv antibiotic usage:</td>
<td>1</td>
<td>1</td>
<td>0.355(not significant)</td>
</tr>
<tr>
<td>Length of hospital stay&gt; 6 days</td>
<td>5</td>
<td>23</td>
<td>0.639(not significant)</td>
</tr>
<tr>
<td>Duration of catheterization &gt; 48 hrs</td>
<td>6</td>
<td>5</td>
<td>0.0014(significant at p&lt;0.05)</td>
</tr>
</tbody>
</table>

**DISCUSSION**

Comprehensive Strategies to detect and prevent CAUTI have been recommended by various organisations and societies worldwide. Two of the most important strategies for prevention of CAUTI are to limit insertion to only those conditions for which there is an indication and to remove catheters as soon as possible. In this study, we found the need for accurate measurement of urinary output in critically ill patients to be the commonest indication for catheterisation. (78.6%)[13]

Muddings et al identify 4 key aspects of urinary catheter lifecycle that can be targeted for prevention namely catheter placement, catheter care, catheter removal and catheter reinserter. A nurse-driven urinary catheter discontinuation protocol for the early removal of unnecessary urinary catheters has been recommended by CDC. This protocol was found to greatly decrease the duration of use for indwelling catheters as well as the incidence of CAUTI, in turn decreasing the cost of health care.[14] In the one -day survey done at the ends of the first month in our study ,among the 20 patients admitted in the intensive care unit,14 patients had an indwelling catheter. Of these 14 patients, all (100%) met indication criteria for urinary catheter insertion. A 100% compliance was found in 5 of 10 catheter care practices (Table 3). In addition, 85.7% compliance was found in Catheter securement leaving 1” slack in tubing, bag not touching floor, bag not overfilled. The surveillance also showed 92.6% compliance each in Drain tubing clip secured to sheet. 100% compliance was found in daily catheter care documentation. Thus the continued need to reinforce the catheter care practices were identified through this survey.

The catheter associated UTI in the surgical intensive care unit was detected in 19.4% of the patients with an incidence rate(IR)of 13.9 and 11.8 per 1000 catheter days during the two months of the study (surveillance of 12.9). The IR has varied depending on the strength of the infection prevention surveillance practices of the institution. Mladenović et al reported an IR ranging from 7.23 to 15.57 from a surgical ICU in Serbia. Mullin et al.a reported a CAUTI rate of 1.9 per 1000 catheter days after a multifaceted and collaborative approach to reduce CAUTI rate.[15-16] Reports from India have also been variable.Datta et al reported CAUTI in 22.22% of the patients with an IR of 9.08/1000 catheter days from an intensive care unit in North India .Singh et al found an IR of 9 per 1000 catheter days during a period of one year. A prospective surveillance done at a large tertiary government hospital in New Delhi, India also revealed an IR of 9.7 per 1000 device days.

Prakash et al evaluated the impact of the bundle care approach on reducing device-associated infections in intensive care units and observed a statistically significant drop in the CAUTI rate by 51.4% from 4.86 in reimplementation to 2.36 per 1000 catheter days in post implementation phase. We observed a fall in the CAUTI rate in the second month following the one day surveillance.

Bacteria can establish colonization of a patient’s bladder within three days of their introduction onto the inner or outer surface of urinary catheters. The introduction of bacteria with urinary catheter use is often associated with catheter-related biofilms. Once a biofilm has developed on the inside or outside surface of a urinary catheter, the only way to eliminate the risk of CAUTI is to remove the catheter. [17] The commonest bacterial pathogen of CAUTI in our study was *Escherichia coli* followed by *Klebsiella pneumoniae* and *Enterococcus spp*. The occurrence of gram negative bacteria causing CAUTI, predominantly *Pseudomonas aeruginosa* and Acinetobacter spp, *Escherichia coli*, *Enterococcus spp*, Candida spp have also been reported as common causative agents in various studies.[18,19] Antimicrobial resistance has been increasing in incidence among device associated infections. ESBL production was detected in 25% of the *E.coli* and *K.pneumoniae* isolates in our study ,though all these isolates were susceptible to carbapenems. Both the isolates of *Enterococcus faecalis* were susceptible to Vancomycin. A high prevalence of ESBL production and carbapenem resistance among gram negative isolates and Vancomycin resistant Enterococci were reported by Datta et al. Venkatraman et al also reported a higher incidence of gram negative isolates such as *K.pneumoniae*. Both isolates were susceptible to Nitrofurantoin, Ciprofloxacin, Tetracycline, high level gentamicin and Vancomycin and resistant to Penicillin and Ampicillin. Eleven of 36 patients had fever (>38°C (30.5%). There was no growth in blood culture in these patients.

Five major risk factors have been identified for CAUTI namely duration of catheterisation, catheter care violations, length of ICU stay, older age and female gender.[20] In our study, on univariate analysis of the various risk factors, duration of catheterisation a major risk factor for CAUTI, while age and gender were not
significantly associated. Mladinovic et al and Datta et al also observed the duration of catheterisation to be a major risk factor. In addition, female gender was observed as a risk factor on multivariate analysis by Mladinovic et al.\textsuperscript{13,16,17}

Some of the drawbacks of the present study were the short duration of study and the lower sample size. The association of catheter care practices and the development of CAUTI could not be analysed as the surveillance was done at a single point of time.

CONCLUSION

Catheter-associated urinary tract infection is an important cause of morbidity among patients in the surgical intensive care unit. Among the multiple risk factors, the most important and modifiable factor is the duration of catheterisation. Preventive strategies include insertion of catheters only when justified with appropriate indications and strict adherence to sterile catheter care practices. Surveillance of the high-risk areas and implementation of infection prevention programmes hold the key to successful reduction of CAUTI.

REFERENCES